Departmental Assessment Plan:

At the end of the Biomedical Engineering Master's Research/Thesis and Coursework program, students will be able to:

<table>
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<tr>
<th>Learning Goals</th>
<th>Measures</th>
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<tr>
<td>Demonstrate proficiency of the subject matter.</td>
<td>Graduate course grades</td>
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<td>Thesis/Report &amp; Defense</td>
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<td>Master’s Self-assessment</td>
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<td>Demonstrate research skills, execute a research project. (thesis and report only)</td>
<td>Thesis Research Proposal</td>
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<td>Thesis/Report &amp; Defense</td>
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<td>Master’s Self-assessment</td>
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<td>Publications</td>
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<td>Conference Publications</td>
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<td>Make a contribution to the discipline. (thesis only)</td>
<td>Thesis/Research Proposal</td>
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<td>Publications</td>
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<td>Conference presentations</td>
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<td>Master’s Self-assessment</td>
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<td>Demonstrate professional skills.</td>
<td>Thesis/Report &amp; Defense</td>
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<td>Teaching evaluations (if applicable)</td>
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<td>Master’s Self-assessment</td>
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<td>Practice responsible conduct of research (field appropriate)</td>
<td>Thesis/Report &amp; Defense</td>
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<td>RCR Training</td>
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MASTER'S ADMISSION PROCESS

Applications will be accepted on a rolling basis. There is no deadline for applying to the master's program.

Master’s students typically do not receive support from the BME department during their studies.

Admission Requirements:

- GPA of 3.0 on a scale of 4.0
  - To convert your GPA to the 4.0 scales, please use this link:

    http://www.foreigncredits.com/Resources/GPA-Calculator/

- GRE: Recommended scores of:
  - 160 Quantative
  - 153 Verbal
  - 3.0 Analytical
  - (Michigan Tech students are exempt)

- TOEFL: Recommended Score of 100 IBT (International Students)

- IELTS: Recommended Overall Band Score of 7.0 (International Students)

The BME graduate committee will review applications approximately biweekly and reject any applications that do not meet the basic requirements.

- All students who have a BS in an engineering discipline are eligible to apply. However, students lacking undergraduate courses in life sciences or biomedical engineering may be required to complete additional courses to correct this deficiency. The advisor and BME graduate program director will approve a plan for satisfying the deficiency.

- Exceptional students with non-engineering BS degrees are also eligible to apply. However, these students may be required to complete additional courses in engineering and/or mathematics to correct the deficiency. The advisor and BME graduate program director will approve a plan for satisfying the deficiency.

- The standard Graduate School admissions process applies.

Advisor Assignment

We recommend that students review the website and contact us with who they would like to set up as their temporary advisor. If they are having trouble selecting an advisor by a specific date (one month prior to arrival on campus) a temporary advisor will be assigned.
Typical Program of Study and Requirements for ALL Master’s Students

- Students can be enrolled in the MS program under three options: Thesis Option, Report Option, and Coursework Option. Students need to indicate their option by completing the MS Plan of Study Form before the end of the first semester in the program. Students are allowed to change their plans while enrolled in the program at any time. This plan must be approved by their BME advisor.

- The following courses are required core courses that each student must take and pass with a minimum of a “B” grade. Students will be required to re-take the course with grades less than “B”.
  - MA5701 Statistical Methods I offered Fall
  - BE5200 Cellular & Molecular Biology II offered Spring

- Graduate students who wish to take 3000/4000 level courses must get special approval from their advisor.

- Students who wish to change their program option (same advisor) must submit a Degree Schedule Form to the Graduate School.

- All graduate students are required to attend all BME graduate seminars. See separate section - Graduate Seminar Series for further information and requirements.

- Students are permitted to take courses outside the BME department as determined by the student and his/her advisor.

- A cumulative GPA for courses counted toward the degree of 3.0 is required for graduation.

- Students who are accepted to the program will be placed under probation if their cumulative GPA for courses counted toward their degree falls below a 3.0. Students with 2 consecutive probation semesters will not be allowed to continue in the program.

- All Graduate School residency and credit requirements must be met.

All students are required to complete a Self-assessment Form every spring semester. They must also meet with their advisor after completion of the assessment.
Coursework Option

This plan requires the minimum of 30 credits be earned through coursework. Research credits taken by students in other plans may not be counted as coursework credits.

- Students must complete the master’s requirements for all students as listed on the Graduate School website, as well as the below requirements for courses:
- A minimum of 30 approved credits (including required core courses)
- Coursework must satisfy the following:
  - 18 credit minimum 5000-6000 classes
  - 9 credit maximum 4000 classes
  - 3 credit minimum 4000 or higher level courses outside the department
  - 12 credit minimum from BME department
- Up to 6 credits taken as Independent Study may be for research-related activities
- The following courses are required core courses, all students must take and pass with a minimum of a “B” grade. Students will be required to re-take the course with grades less than “B”.
  - MA5701 Statistical Methods I offered Fall
  - BE5200 Cellular & Molecular Biology II offered Spring

Graduate students who wish to take 3000 or 4000 level courses must get special approval from their advisor.

All other deadlines and requirements for completion of the master's coursework are located on the Graduate School website.

Coursework students are required to complete a Self-assessment and meet with their advisor annually to ensure they are taking and enrolling in the correct courses to fulfill degree requirements.
Required Deadlines – Coursework Option

Each MS student enrolled in the Department of Biomedical Engineering (BME) MS program is required to adhere to the following deadlines.

REMEMBER THAT FORMS ARE AVAILABLE ON THE GRADUATE SCHOOL WEBSITE, MyMichiganTech AND THE BIOMEDICAL ENGINEERING’S GRADUATE WEBSITE.

STUDENTS ARE REQUIRED TO MONITOR THEIR ACCOUNTS AND SUBMIT FORMS BY THE REQUIRED DEADLINES.

Newly accepted student responsibilities upon arrival on campus and prior to 1st day of class:

Obtain Husky Card

International students report to International Programs and Services (IPS)

Attend Graduate School Orientation

- Complete Basic Responsible Conduct of Research Training:
  - Provided during Graduate School Orientation
  - Or
  - www.mtu.edu/gradschool/administration/academics/resources/rcr/online-basic/
- Complete on MyMichiganTech the Patent, Research, & Proprietary Rights Agreement Form
- Submit official proof of previous degrees earned to the Graduate School

Attend BME Department Grad Student Orientation Meeting.

Beginning of 1st semester:

- Complete Campus Clarity Training
  - www.mtu.edu/gradschool/administration/academics/resources/rcr/online-basic/

Prior to the end of the 1st semester:

- Complete Advisor Recommendation Form (M2) and submit to the Graduate School. A copy of the document is also required for department files. This process is to choose your advisor.
- Proposed coursework and MS option: Biomedical Engineering MS Plan of Study Form. The proposed coursework will include the classes taken during the first semester. This must be signed by the advisor. This form is for department files only.

2nd or 3rd semester:

- Complete Advanced Responsible Conduct of Research Training:
  - www.mtu.edu/research/administration/integrity-compliance/responsible-conduct/training/courses/
  - Students are recommended to take these courses fall or spring semester

At the end of every year:

- Submit Master’s Coursework Student Self-assessment Form to advisor before the end of the spring semester.
- Arrange meeting with advisor to review the self-assessment.
- The purpose of the self-assessment is to keep the advisor abreast of progress and garner their feedback. The advisor may determine if more frequent meetings are required.

Semester before Planned Degree Completion:

- Submit Degree Schedule to the Graduate School (M4).
SEMESTER OF PLANNED DEGREE COMPLETION:

Students need to monitor their MyMichiganTech account for required Graduate School forms and deadlines.

- Submit Degree Completion Form to the Graduate School.
- Submit Verification of Final Degree Requirements Form to Graduate School.
- Advisor complete Biomedical Engineering Evaluation of MS Graduate Student Outcomes – Coursework using the Biomedical Engineering MS Evaluation Rubric.

Please refer to the Graduate School guidelines for remaining procedures at:

www.gradschool.mtu.edu/td/submission/#final or MyMichiganTech
Master's Thesis Option

Under this master's option a student will select a project of research interest. The program requires a research thesis prepared under the supervision of the advisor. The thesis describes a research investigation and its results. The scope of the research topic for the thesis should be defined in such a way that a full-time student could complete the requirements for a master's degree in twelve months or three semesters following the completion of coursework by regularly scheduling graduate research credits. The thesis must be prepared following the current Graduate School procedures.

Upon completion of the course requirements and research thesis, a master's thesis student will present a defense of their work. The defense must include the faculty advisor and the committee. The defense will be open to the public. Upon dismissal of the general audience the committee will continue to question the student. The committee will evaluate the student's ability to present and defend the thesis using the Biomedical Engineering MS Evaluation Rubric and record the results on the Biomedical Engineering Evaluation of MS Graduate Student Outcomes - Thesis. Students must report the results of their oral examination and submit a final thesis to the Graduate School prior to completing their degree.

Visit the deadlines section on the Graduate School website for detailed information about required forms and due dates.
Thesis Option Course Requirements

Under this plan, the student is required to produce a research thesis with the supervision of an advisor. The minimum course requirements are as follows:

- Students must complete the master’s requirements for all students as stated on the Graduate School website, as well as the below requirements for courses:
- A minimum of 30 approved credits (including required core courses)
- 20 credit minimum of relevant coursework
  - 12 credit minimum 5000-6000 level courses
  - 9 credit maximum 4000 level courses
  - 3 credit minimum 4000 or higher level courses outside the department
  - 12 credit minimum from BME department
- 6 to 10 research credits

The following courses are required core courses, all students must take and pass with a minimum of a “B” grade. Students will be required to re-take the course with grades less than “B”.

- MA5701 Statistical Methods I offered Fall
- BE5200 Cellular & Molecular Biology II offered Spring

Graduate students who wish to take 3000 or 4000 level courses must get special approval from their advisor.

All other deadlines and requirements for completion of the master’s thesis are located on the Graduate School website.
Master's Report Option

Under this master's option a student will select an independent project of research interest. The student will prepare a report describing the results of the project. The scope of the research topic for the report should be defined in such a way that a full-time student could complete the requirements for a master's degree in twelve months or three semesters following the completion of course work by regularly scheduling graduate research credits. Reports must be prepared following the formatting guidelines from the Graduate School.

Upon completion of the course requirements and project, the student must present the results of their report during their defense. The defense must include the faculty advisor and the committee. The defense will be open to the public. Upon dismissal of the general audience the committee will continue to question the student. The committee will evaluate the student's ability to present and defend the report using the Biomedical Engineering MS Evaluation Rubric and record the results on the Biomedical Engineering Evaluation of MS Graduate Student Outcomes - Report. Students must report the results of their oral examination and submit a final report to the Graduate School prior to completing their degree.

Visit the deadlines section on the Graduate School website for detailed information about required forms and due dates.
Report Option Course Requirements

Under this plan, the student is required to produce a report describing the results of an independent study project. At least 24 of the 30 credits must be earned in coursework other than the project.

- Students must complete the Master’s requirements for all students as stated on the Graduate School website, as well as the below requirements for courses for the report option;
- A minimum of 30 approved credits (including required core courses).
- 24 credit minimum of course work
  - 12 credit minimum 5000-6000 level courses
  - 12 credit maximum 4000 level courses
  - 3 credit minimum 4000 or higher level courses outside the department
  - 12 credit minimum from BME department
- 2 to 6 research credits

The following courses are required core courses, all students must take and pass with a minimum of a “B” grade. Students will be required to re-take the course with grades less than “B”.

- MA5701 Statistical Methods I offered Fall
- BE5200 Cellular & Molecular Biology II offered Spring

Graduate students who wish to take 3000 or 4000 level courses must get special approval from their advisor.
Required Deadlines – Thesis and Report Option

Each MS student enrolled in the Department of Biomedical Engineering (BME) MS program is required to adhere to the following deadlines.

REMEMBER THAT FORMS ARE AVAILABLE ON THE GRADUATE SCHOOL WEBSITE, MyMichiganTech AND THE BIOMEDICAL ENGINEERING’S GRADUATE WEBSITE.

STUDENTS ARE REQUIRED TO MONITOR THEIR ACCOUNTS AND SUBMIT FORMS BY THE REQUIRED DEADLINES.

Newly accepted student responsibilities upon arrival on campus and prior to 1st day of class:

Obtain Husky Card

International students report to International Programs and Services (IPS)

Attend Graduate School Orientation

- Complete Basic Responsible Conduct of Research Training:
  - Provided during Graduate School Orientation
  - Or
  - www.mtu.edu/gradschool/administration/academics/resources/rcr/online-basic/
- Complete on MyMichiganTech the Patent, Research, & Proprietary Rights Agreement Form
- Submit official proof of previous degrees earned to the Graduate School

Attend BME Department Grad Student Orientation Meeting

Beginning of 1st semester:

- Complete Campus Clarity Training
  - www.mtu.edu/gradschool/administration/academics/resources/rcr/online-basic/
- Complete Advisor & Committee Recommendation Form (M2) and submit to the Graduate School. A copy of the document is also required for department files. This process is to confirm who the advisor will be.

2nd semester:

- Complete Advisor & Committee Recommendation Form (M2) and submit to the Graduate School. A copy of the document is also required for department files. This process is to choose your advisory committee. This committee will consist of the student’s advisor, and at least 3 additional full-time faculty members. Two members must have a primary appointment in the BME department. There must be at least one member who does not have a primary appointment in the BME department.
- Proposed coursework and MS option: Biomedical Engineering MS Plan of Study Form. The proposed coursework will include the classes taken during the first semester. This must be signed by the advisor. This form is for department files only.

2nd – 3rd semester:

- Complete Advanced Responsible Conduct of Research Training:
  - www.mtu.edu/research/administration/integrity-compliance/responsible-conduct/training/courses/
  - Students are recommended to take these courses fall or spring semester.

Every semester:

- Must attend a minimum of 6 BME graduate seminars each semester. Attendance of other department seminars is required if there are not enough BME seminars offered.
At the end of Spring semester:

- Submit Graduate Student Self-assessment Form to advisor.
- Arrange meeting with advisor to review the self-assessment.
- The purpose of the self-assessment is to keep the advisor abreast of progress and garner their feedback. The advisor may determine if more frequent meetings are required. This also provides graduate students with a review of their performance and expectations for the coming semester. Negative reviews will reflect in the graduate student's grade.

Semester before Planned Degree Completion:

- Submit Degree Schedule to the Graduate School (M4).

SEMESTER OF PLANNED DEGREE COMPLETION:

Students need to monitor their MyMichiganTech account for required Graduate School forms and deadlines.

- Submit Degree Completion Form to the Graduate School.

Thesis/Report Defense:

The thesis/report defense is open to the public. The student will give a presentation to the audience. The general audience will first question the student on the proposal. Upon dismissal of the general audience, the thesis/report committee members will continue to question the student. The committee will evaluate the student’s ability to present and defend the thesis/report using the Biomedical Engineering MS Evaluation Rubric and record the results on the Biomedical Engineering Evaluation of MS Graduate Student Outcomes – Thesis or – Report. If the student does not pass the defense, he/she can retake the defense a second time. Failure in the second defense will result in the dismissal of the student from the thesis/report MS program. The student will have the option to complete the MS degree with the coursework option.

2 weeks prior to Defense:

- Provide the date, time, building/room number and title of defense to the departmental coordinator. M&M 309 staff can reserve a room for the defense.

- Submit Pre-defense Form & Defense Draft (M5) to the Graduate School and advisory committee. Committee members may request to have the defense draft turned in sooner.

On the day of your Defense:

- Bring a copy of the Report on Final Oral Examination Form (M6) with you to your defense.

Please refer to the Graduate School guidelines for remaining procedures at:

www.gradschool.mtu.edu/td/submission/#final or MyMichiganTech
Graduate Seminar Series

Attendance of all Biomedical Engineering Graduate Seminars is required.

PhD students are required to present a seminar to BME faculty and BME graduate students.

Faculty attending the PhD student's seminar will use the Biomedical Engineering PhD Evaluation Rubric and record the results on the Biomedical Engineering Evaluation of PhD Graduate Student Outcomes – Seminar.

The department coordinator will email notifications about the date, time, and location for seminars that will occur (a seminar will not be held every week so please watch your email closely).

Requirements:

- All graduate students MUST attend all Biomedical Engineering seminars.
  - There will be a sign in sheet at the seminar to ensure attendance.
- Graduate students must attend 6 seminars per semester (emails are sent from the department coordinator announcing other departmental seminars as well). If the BME department does not hold 6 seminars per semester, students must attend seminars from other departments.
  - BME PhD proposal defense, dissertation defense and MS Thesis/Report defense are considered to be part of the seminar series.
- Graduate students must write up a brief summary of each seminar attended. They must have their advisor approve and sign the summary and then turn it in to staff at the front desk.
- Failure to attend the appropriate number of seminars will result negatively on student's evaluations that occur each semester and will negatively impact their research grade.

Events that are not acceptable for seminar assessments:

- Seminars must be of a scientific or technical research topic
- Webinars
- Graduate School workshops or training sessions
- PhD proposal defense, dissertation defense and MS Thesis/Report defense outside of the BME department
- Conferences
- Tech Talk Series
Biomedical Engineering Graduate Courses

BE 5000 - Biomedical Masters Research Includes the study of an acceptable biomedical engineering problem and the preparation of a report or thesis.
Credits: variable to 12.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer

BE 5115 - Finite Element Modeling The course teaches both fundamentals of finite element theory and hands-on experience for bioengineers.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring

****BE 5200 - Cellular and Molecular Biology II Covers, at an advanced level, the general principles and engineering applications of science and biology, including cell biology, physiology, molecular biology, genetics, and biotechnology.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring

BE 5230 – Stem Cell and Tissue Engineering This course will introduce (1) basic concepts of tissue engineering, (2) scaffold materials and biotechnologies for tissue engineering, (3) basic concept of stem cells, (4) review of stem cell sources and related policies, (5) current progress in stem cell research, (6) application of stem cells in tissue engineering and regenerative medicine.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring

BE 5250 - Biomedical Optics Light plays a significant role in modern clinical diagnostics and in the clinical treatment of disease. Examples include non-invasive surgery, optical biopsy, and cancer therapy. This course will focus on the study of how light propagates through biological tissue.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring - Offered alternate years beginning with the 2014-2015 academic year.

BE 5300 - Polymeric Biomaterials A specialized study of polymers used in biomedical engineering. Topics include: processing-structure-properties relationships for polymers, polymer fibers and composites, degradation of polymers, and medical applications for composite biomaterials.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring - Offered alternate years beginning with the 2009-2010 academic year.

BE 5330 - Biomimetic Materials This course introduces students to biologically inspired approaches to design functional biomaterials. Topics include the discovery and incorporation of biological designs into novel materials and their application in the biomedical field.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall - Offered alternate years beginning with the 2014-2015 academic year.

BE 5335 - Smart Polymers This course introduces students to smart polymers that change their physical properties in response to various environmental stimuli. Topics include the molecular origin of the stimuli responsiveness of these materials and their application in the biomedical field.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall - Offered alternate years beginning with the 2015-2016 academic year.

BE 5350 - Cell Biomechanics and Mechanical Transduction This course is designed to introduce the mechanical analysis and characterization of mammalian cells. Mechanotransduction, whereby cells detect loading and respond to the morphology and mechanical properties of the surrounding extracellular matrix, will be emphasized.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall

BE 5390 - Scientific Computing Offers insight into advanced scripting, parallel computing with traditional CPUs and hardware accelerators, data analysis, and visualization. Students will get hands-on experience in designing, building, securing, managing, and using a HPC cluster in compliance with federal regulations.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall, Spring
BE5410 – Medical Imaging This course covers the physical nature of the interactions between the waves and matter, especially the biological tissues, principle imaging modalities used in modern medicine and the common techniques used for the processing of the resulting images.
Credits: 3.0
Semesters Offered: Spring – Offered alternate years beginning with the 2018-2019 academic year.

BE 5510 - Cardiovascular Engineering Fundamental cardiovascular pathology and the biomedical engineering approaches being developed and used toward problems resulting in significant cardiovascular deficiency such as myocardial infarction, chronic kidney disease, atherosclerosis, and heart valve disease.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall

BE5670 – Micro & Nano Technologies This course introduces students to micro- & nano- technologies and the processes involved in their manufacturing. Particular emphasis will be on the use in biomedical applications. Goal is to provide beneficial research and development to the industry.
Credits: 3.0
Semesters Offered: Fall

BE 5700 - Biosensors This course introduces the student to the fundamentals of biosensor development and applications. It provides an understanding of biological components, immobilization methods, transducers, and fabrication techniques.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall - Offered alternate years beginning with the 2009-2010 academic year

BE 5755 - Medical Devices An introduction to medical devices used for diagnosis, monitoring, and treatment in clinical medicine. Topics covered include product planning, reliability, clinical trial design, regulatory as well as technical aspects of common medical devices.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall

BE 5770 - Biomedical Microcontrollers The focus of this course is to provide biomedical engineering students the necessary skills to develop microcontroller-based devices. Provides basic knowledge on computer programming languages, microcontrollers, digital circuits, and microcontroller development kits. Students will design and fabricate a microcontroller-based device using a microcontroller development kit for a specific biomedical application.
Credits: 3.0 Lec-Rec-Lab: (1-0-2)
Semesters Offered: Fall - Offered alternate years beginning with the 2016-2017 academic year

BE 5800 - Advanced Biomaterials Interfaces This course introduces the students to the effects of topography and texture on the performance of biomaterials. Special emphasis is placed on tissue engineering scaffolds and microfabrication and nanofabrication techniques. Some of the topics include: self-organization of biomembranes and supramolecular systems, bioactive materials, and the molecular basis for surface recognition and masking. Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring - Offered alternate years beginning with the 2010-2011 academic year

BE 5850 - Tissue Mechanics This course integrates continuum mechanics, experiments and computational methods to understand soft tissue mechanics. The first half of the course is dedicated to building continuum mechanics foundation, which will be used to formulate constitutive equations for arteries and the heart in the second half.
Credits: 3.0 Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall

BE5900 – Biomedical Engineering Master’s Topics Biomedical engineering courses will be offered as professional electives dependent upon the interest of the faculty.
Credits: variable to 6.0; May be repeated
Semesters Offered: Fall, Spring, Summer

BE6000 – Biomedical Engineering Doctoral Research Includes the study of an acceptable biomedical engineering problem and the preparation of a report or thesis.
Credits: variable to 12.0; May be repeated; Graded Pass/Fail Only
Semesters Offered: Fall, Spring, Summer
BE 6900 - Biomedical Engineering Doctoral Topics Biomedical engineering courses will be offered as professional electives dependent upon the interest of the faculty.
Credits: variable to 6.0; May be repeated
Semesters Offered: Fall, Spring, Summer

****MA 5701 - Statistical Methods Introduction to design, conduct, and analysis of statistical studies, with an introduction to statistical computing and preparation of statistical reports. Topics include design, descriptive, and graphical methods, probability models, parameter estimation and hypothesis testing.
Credits: 3.0 Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall

****REQUIRED CORE COURSE:  BE 5200 - Cellular and Molecular Biology II
MA 5701 - Statistical Methods

REQUIRED CORE COURSES MUST HAVE A GRADE OF “B” OR BETTER. STUDENTS WILL BE REQUIRED TO RE-TAKE THE COURSE WITH GRADES LESS THAN “B”.